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#8 4-25-03 D.OA

**Patent**

# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | |
|---|---|---|
| In re the application of | : | |
| Matthew J. Carey et al. | : | Group Art Unit: 1773 |
| Serial No.: 09/916,390 | : | Examiner: Holly C. Rickman |
| Filed: 07/26/2001 | | |

Title: DUAL-LAYER PERPENDICULAR MAGNETIC RECORDING MEDIA WITH LAMINATED UNDERLAYER FORMED WITH ANTIFERROMAGNETICALLY COUPLED FILMS

## DECLARATION BY ALL INVENTORS OF PRIOR INVENTION IN THE UNITED STATES TO OVERCOME CITED PATENT (37 CFR§ 1.131)

We, the undersigned inventors of the subject matter claimed in the above-identified patent application, declare as follows:

1. This declaration is to establish completion of the invention in this application in the United States on a date prior to August 25, 2000, which is the filing date in the United States of a provisional application 60/227,943 corresponding to non-provisional application 09/939,190 which was published on March 2, 2002 as US2002/0028357 and cited by the Examiner to reject claims of this application under 35 USC §§ 102(e) and 103(a).

2. We are all of the inventors of the subject matter of pending claims 1-9, 11-24 and 26 in the above-identified patent application filed July 26, 2001.

3. An IBM invention disclosure describing the invention that is claimed in the pending claims of this application was written prior to August 25, 2000 and was submitted to IBM's Intellectual Property Law department at the IBM Almaden Research Center in San Jose, California, USA prior to August 25, 2000. Attached to this declaration as Exhibit A are true and correct copies of pages 1 and 5 of said invention disclosure, with dates blocked out.

4. The invention of pending independent claims 1 and 15, one embodiment of which includes a laminated underlayer of IrMn/{CoFe/Ru}4/CoFe with five CoFe ferromagnetic layers, four Ru spacer layers, and a bottom IrMn antiferromagnetic layer, as described with respect to Fig. 4 of this application, was actually reduced to practice in San Jose, California USA prior to

August 25, 2000. Fig. 4 of this application is identical to Fig. 4 on Exhibit A (page 5) of the previously described IBM invention disclosure and shows measured M-H loops for this laminated structure.

5. The conception and all work in reducing the invention of pending claims 1 and 15 to practice occurred in the United States.

6. From the above statements and attached documents it can be seen that the invention of pending claims 1 and 15 in this application was made in the United States prior to the effective date of the cited reference.

7. Each of us hereby further states that all statements made herein of his own knowledge are true and all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and with the knowledge that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

This declaration was executed by each of us on the date and at the location indicated next to our respective names.

Mathew J. Carey — Executed at San Jose, CA on 4/11/03

Yoshihiro Ikeda — Executed at San Jose, CA on 4/10/03

Neil Smith — Executed at San Jose, CA on 4/11/03

Kentaro Takano — Executed at San Jose, CA on 4/10/03

# Disclosure ARC8-2000-0262

**Created By:** Neil Smith **Created On:** [redacted]
**Last Modified By:** Neil Smith **Last Modified On:** [redacted]

*** IBM Confidential ***

Required fields are marked with the asterisk (*) and must be filled in to complete the form .

## Summary

| | |
|---|---|
| Status | Under Evaluation |
| Processing Location | ARC |
| Functional Area | X1IA - Recording Heads Technology - (Bob Scranton) |
| Attorney/Patent Professional | Thomas Berthold/Almaden/IBM |
| IDT Team | Thomas Berthold/Almaden/IBM |
| Submitted Date | [redacted] |
| Owning Division Select | RES |
| PVT Score Calculate | To calculate a PVT score, use the 'Calculate PVT' button. |
| Incentive Program | |
| Lab | |
| Technology Code | |

## Inventors with Lotus Notes IDs

Inventors: Neil Smith/Almaden/IBM, Matthew Carey/Almaden/IBM

| Inventor Name > denotes primary contact | Inventor Serial | Div/Dept | Manager Serial | Manager Name |
|---|---|---|---|---|
| > Smith, Neil | 997776 | 22/K66D | 986325 | Tang, Denny D. |
| Carey, Matt | 988842 | 22/K66G | 171649 | Gurney, Bruce A. |

## Inventors without Lotus Notes IDs

## IDT Selection

| IDT Team: | Attorney/Patent Professional: |
|---|---|
| Thomas Berthold/Almaden/IBM | Thomas Berthold/Almaden/IBM |

**Response Due to IP&L : 09/28/2000**

## Main Idea

### *Title of disclosure (in English)

improved underlayer for perpendicular recording media

### *Idea of disclosure

1. Describe your invention, stating the problem solved (if appropriate), and indicating the advantages of using the invention.

The invention includes the use of antiparallel-coupled (AP-coupled) multilayers as the constituents for the soft underlayer portion of a perpendicular recording media. It solves the problem of providing for a magnetically soft underlayer without undesirable domain walls and associated

EXHIBIT A

including those on top and bottom, respond with equal amplitude of rotation in response to a uniform strength field H. In the special case of a bilaminate, one would typically choose $t_{fm\text{-}bot} = t_{fm\text{-}top} = t_{fm}$, although here $H_{ap} = 2*J_{ap}/(M_s*t_{fm})$ is only half as strong as for the general multilaminate case.

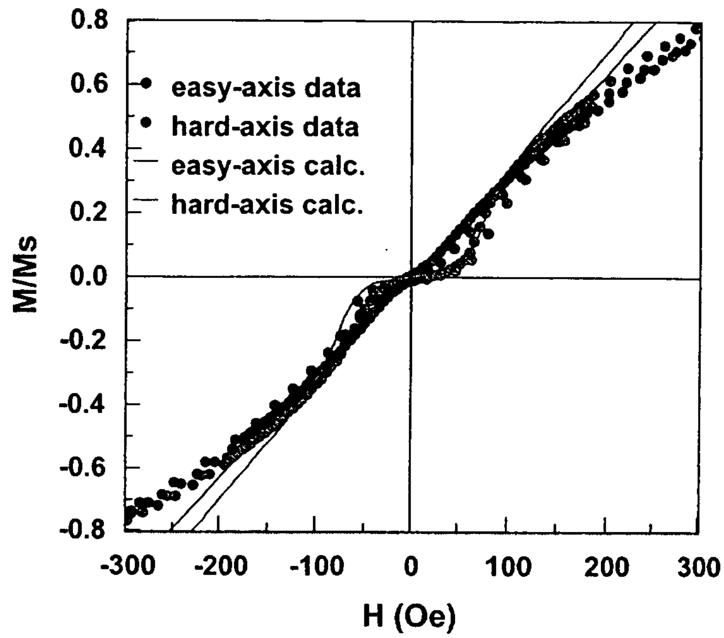


Fig. 4

Fig. 4 shows some VSM-measured M-H loops for an IrMn/{CoFe/Ru}$_4$/CoFe AP laminate with five CoFe FM layers. Layer thicknesses are $t_{CoFe}$ = 50 nm, $t_{Ru}$ = 0.7 nm, along with $t_{CoFe\text{-}bot}$ = 28 nm, and $t_{CoFe\text{-}top}$ = 25 nm. Other measured magnetic parameters include $H_k$ = 20 Oe and $J_{pin}$ = 0.15 erg/cm for IrMn/CoFe. The M-H loops for both hard-axis (e.g., circumferential) and easy-axis (e.g., radial) oriented fields H are shown. For moderate flux levels of $M/M_s < 0.8$, the data can be reasonably well fit by micromagnetic simulations using the single fitting parameter $H_{ap}$ = 300 Oe, corresponding to $J_{ap} \cong 0.54$ erg/cm$^2$. (Dispersion in the strength of $J_{ap}$ over the 1-inch diameter coupon may account for the observed large-H tails in the measured M-H loops.) The measured M-H loops show virtually zero remanence, and have well defined hard and easy axes of magnetization. In particular, the hard-axis loop shows near ideal linear behavior for small to moderate H fields, where the data is well described by the simple relation $M/M_s = H/(H_k + H_{ap})$. In contrast, the easy-axis loop shows rather limited $M/M_s$ response for smaller H-fields < ~ 70 Oe ($\cong$ sqrt($Hk*H_{ap}$) as predicted by theory) where the laminate magnetizations remain parallel or antiparallel to the applied field. However, at larger fields H where AP coupling dominates over anisotropies, the laminate magnetization vectors orient themselves to the H-field as shown in Fig. 3, and easy and hard-axis loops become very similar. For this particular multilaminate of total magnetic thickness of 200 nm, $\mu_{rot} = B_s(H_k + H_{ap}) \cong 60$, as compared to $\mu_{rot} = B_s/(H_k + H_{pin}) \cong 700$ as achieved by a single laminate IrMn/CoFe with $t_{CoFe}$ = 200 nm (not shown). This demonstrates the ability of the present invention to control permeability over a wide range. Somewhat more optimal values of $H_{ap}$ ~ 100 Oe and $\mu_{rot} \cong$ 100-200 should be readily obtainable by design, e.g., by increasing $t_{CoFe}$ to 100-150 nm, and/or increasing $t_{Ru}$ somewhat to weaken the coupling strength $J_{ap}$, as described by previous formulae for these quantities .



[redacted]

EXHIBIT A